TECHNICAL NOTES

NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS

No. 495

EFFECT OF THE SURFACE CONDITION OF A WING ON THE AERODYNAMIC CHARACTERISTICS OF AN AIRPLANE

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SUMMARY

In order to determine the effect of the surface conditions of a wing on the aerodynamic characteristics of an airplane, tests were conducted in the N.A.C.A. full-scale wind tunnel on the Fairchild F-22 airplane first with normal commercial finish of wing surface and later with the same wing polished. Comparison of the characteristics of the airplane with the two surface conditions shows that the polish caused a negligible change in the lift curve, but reduced the minimum drag coefficient by 0.001. This reduction in drag if applied to an airplane with a given speed of 200 miles per hour and a minimum drag coefficient of 0.025 would increase the speed only 2.9 miles per hour, but if the speed remained the same, the power would be reduced 4 percent.

INTRODUCTION

With the speed of military and commercial airplanes increasing rapidly, many of the problems of racing airplanes are being encountered in service types, among these problems is the one of surface condition of the wings. As large increases in speed have been claimed for racing airplanes as a result of polishing the surfaces, and also because it has been thought that polishing the surfaces affected the maximum lift, tests were conducted to determine the effect of polishing the wing surfaces upon the aerodynamic characteristics of a small monoplane. The tests were conducted first with the surface of the wing in normal condition and later with the surface highly polished.

EQUIPMENT AND TESTS

The airplane used for the tests was a Fairchild F-22 parasol monoplane with a wing of CYH airfoil section. The principal dimensions of the airplane are given on the plan and elevation views shown in figure 1. The wing was made of the customary wood and fabric construction and the surface of the covering was finished in accordance with standard commercial practice. Figure 2 is a photomicrograph of the original surface.

The propeller and horizontal tail surfaces were removed and the lift and drag characteristics were determined for the airplane with the original wing surface condition and later with the surface of the wing polished. The polishing process consisted of adding 12 spray coats of clear lacquer to fill the surface and 3 coats of wax. The surface was rubbed and polished after the application of each coat of lacquer or wax. A photomicrograph of the highly polished surface is shown in figure 3.

The tests were conducted in the N.A.C.A. full-scale wind tunnel. A description of this equipment is given in reference 1; a photograph of the airplane as mounted in the tunnel is shown in figure 4.

PRESENTATION AND DISCUSSION OF RESULTS

Curves of the lift and drag characteristics of the airplane at an air speed of approximately 58 miles per hour, with the wing in both the original and the polished conditions, are presented in figure 5. The lift curve was not changed as a result of the polishing of the wing except near the peak, where the maximum value was increased 1.4 percent.

In order to determine the scale effect upon minimum drag, the drag forces at small angles of attack were measured at air speeds varying from 58 to 100 miles per hour. The results are presented in figure 6. The minimum drag coefficient of the airplane with the polished wing at 100 miles per hour was 0.001 (2.4 percent) less than that for the airplane with the original surface condition of the wing. Although the scale effect on the airplane with either surface condition of the wing is large, the correction is

the same for both conditions and, since there is practically no correction between 80 and 100 miles per hour, it is probable that the difference in minimum drag coefficient is applicable at the speed of 200 miles per hour.

If a given airplane be assumed to have a top speed of 200 miles per hour and a minimum drag coefficient of 0.025 with a wing surface similar to that of the original wing on the Fairchild F-22, polishing the wing to the same smoothness used for these tests would increase the top speed only 2.9 miles per hour. This is a small increase in speed, but if the top speed of the airplane were to remain the same, the power would be reduced by 4 percent.

CONCLUSIONS

The conclusions to be drawn from the investigation are that: Polishing the wing had a negligible effect upon the lift characteristics but reduced the minimum drag coefficient of the airplane by 0.001. If this reduction in drag were applied to an airplane with a given speed of 200 miles per hour and a minimum drag coefficient of 0.025, the speed would be increased only 2.9 miles per hour, but at the same speed it would permit a reduction in power of 4 percent.

Langley Memorial Aeronautical Laboratory,
National Advisory Committee for Aeronautics,
Langley Field, Va., April 5, 1934.

REFERENCE

1. DeFrance, Smith J.: The N.A.C.A. Full-Scale Wind Tunnel. T.R. No. 459, N.A.C.A., 1933.

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Langley Memorial Aeronautical Laboratory,
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REFERENCE

1. DeFrance, Smith J.: The N.A.C.A. Full-Scale Wind Tunnel. T.R. No. 459, N.A.C.A., 1933.

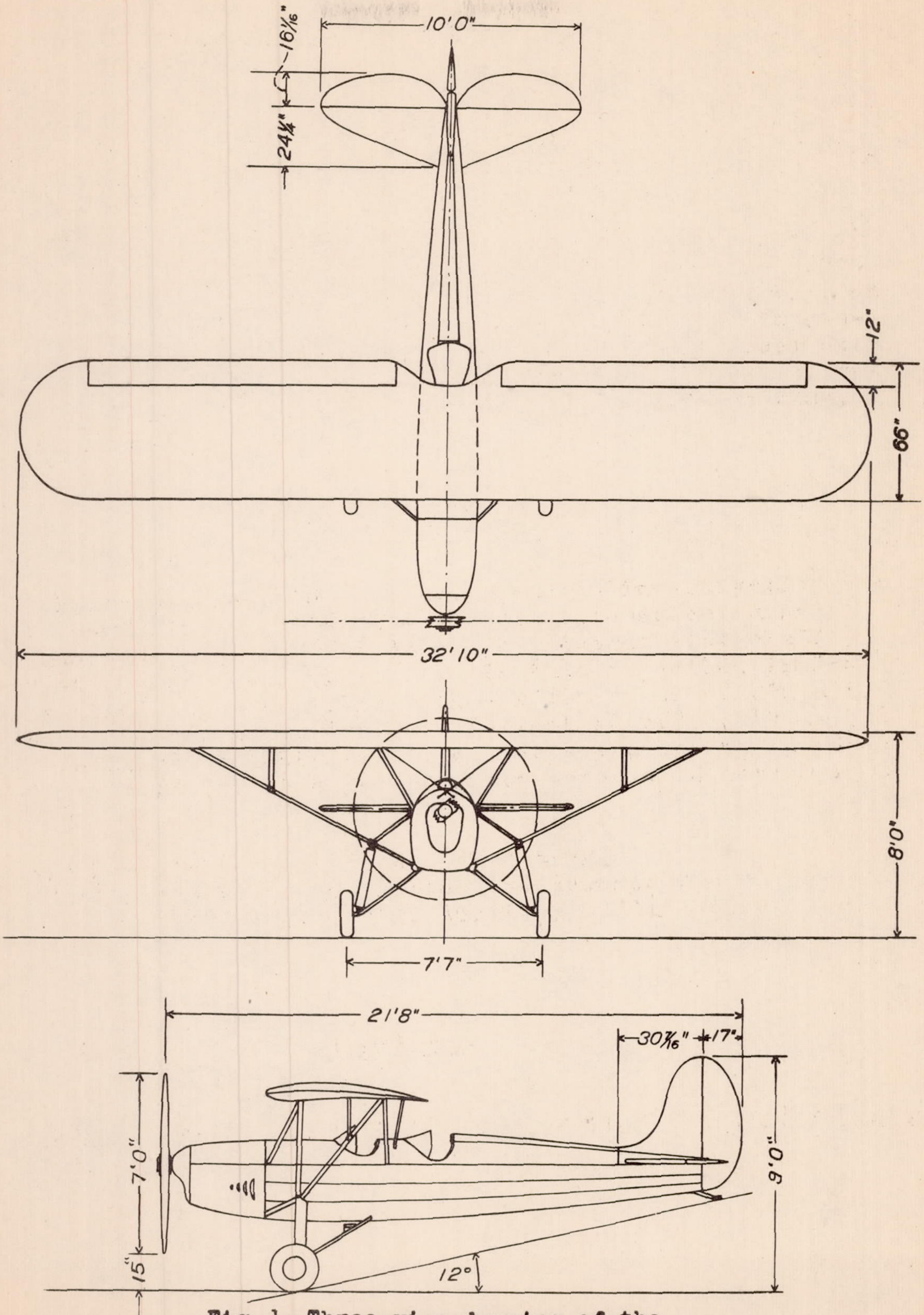

Fig. 1 - Three-view drawing of the Fairchild F-22 airplane.

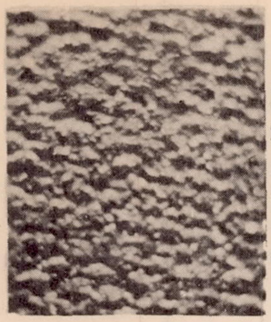

Figure 2.- Photomicrograph of original surface of wing (10X)

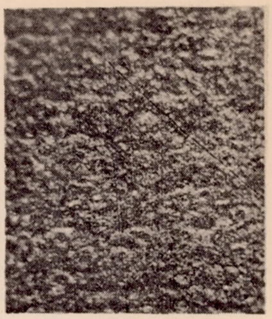

Figure 3.- Photomicrograph of polished surface of wing (10X)

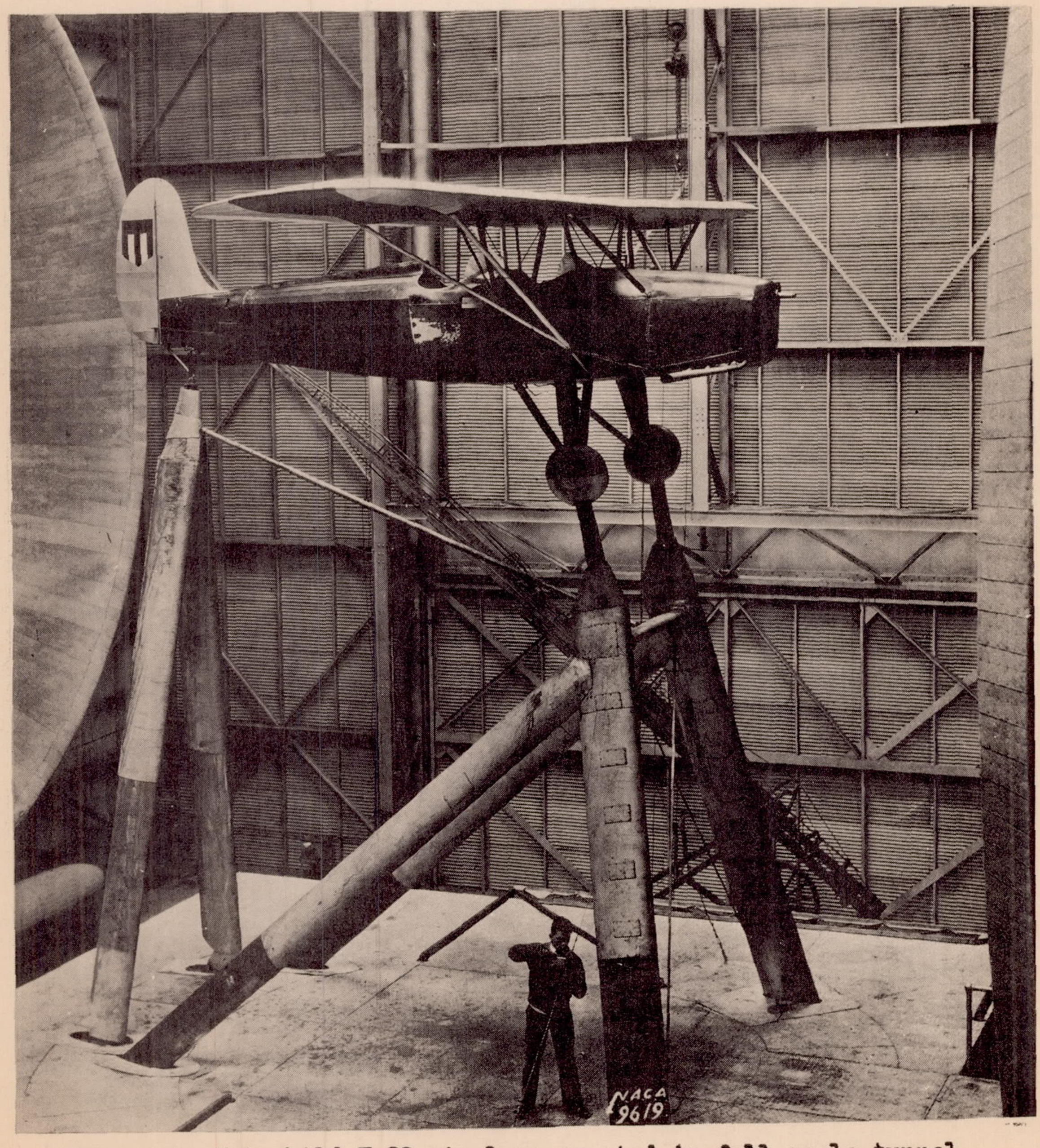

Figure 4.-Fairchild F-22 airplane mounted in full-scale tunnel.

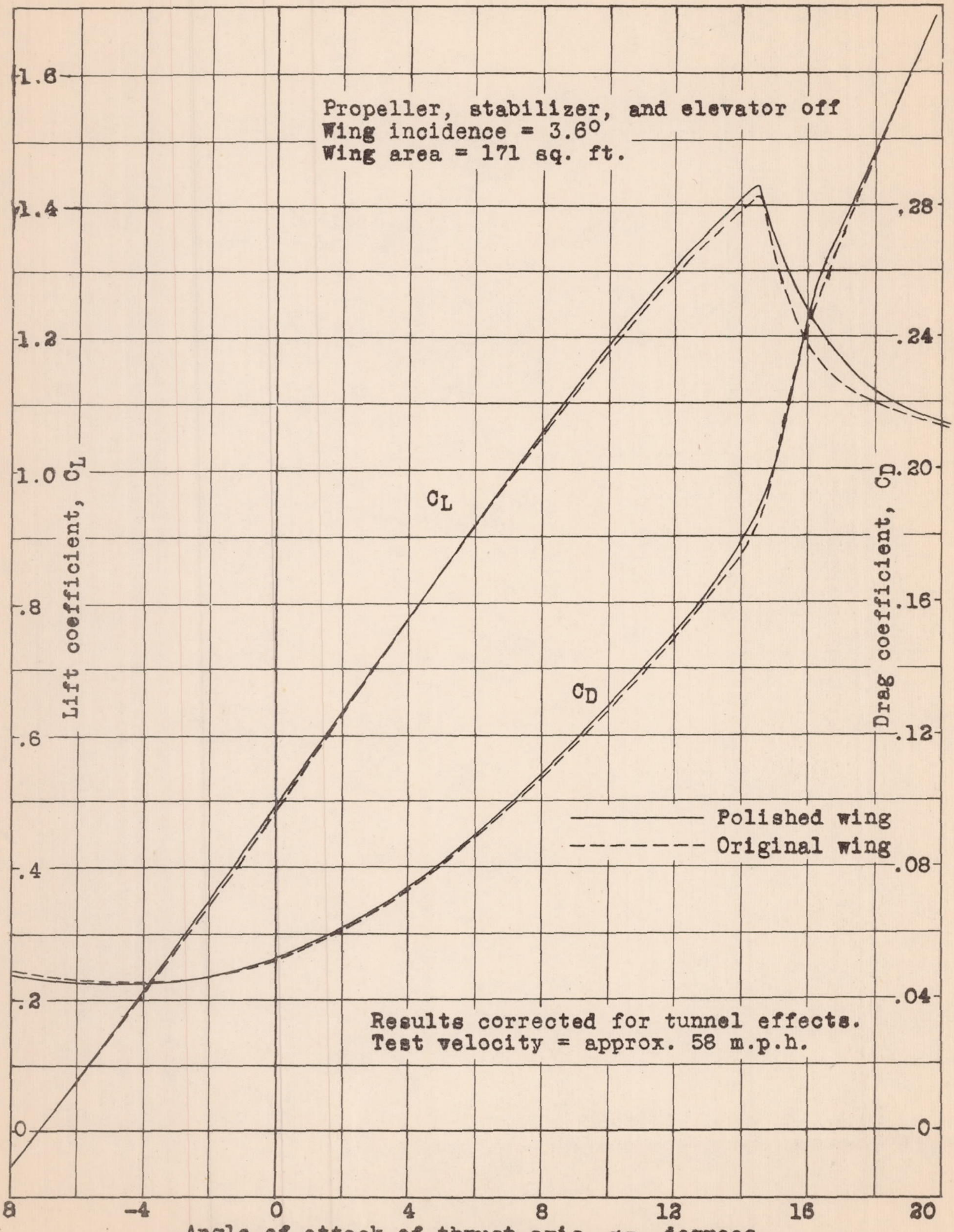

Figure 5.- Lift and drag characteristics of Fairchild F-22 airplane with original and polished wing surfaces.

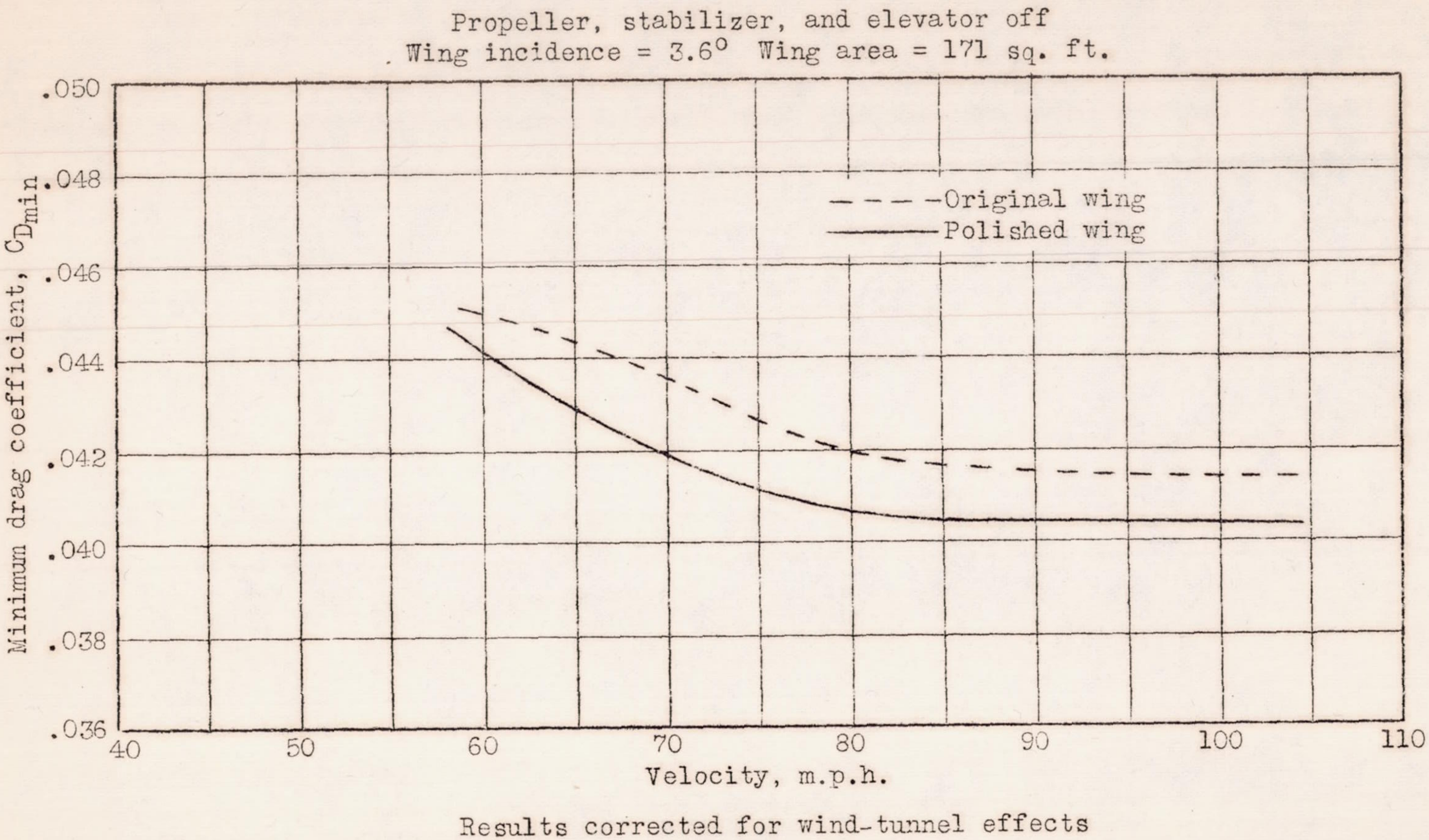

Figure 6.-Scale effect on $C_{D_{min}}$ for Fairchild F-22 with original and polished wing surfaces.